

Please cancel claim 5 without prejudice or disclaimer thereto.

### REMARKS

Reconsideration of the outstanding rejections in view of the above amendments and following remarks is respectfully requested.

Claims 1-4 are now pending. Claims 1-4 have been amended and claim 5 has been cancelled. The amendments to claims 1-4 have been made to better define the present invention, in order to overcome the rejections under 35 U.S.C. § 112, and are not intended for the purpose of overcoming rejections based on prior art. Support for the amendments to claims 1-4 is found throughout the specification. No new matter has been introduced by the above amendments and accordingly, entry thereof is requested.

Applicants' use of the term "adjacent" has the meaning as defined in *Webster's Collegiate Dictionary*, 10<sup>th</sup> Ed., pg. 14 (1993), copy attached. Further, applicants intend that use of the term "adjacent" is interchangeable with the meaning of the term "neighboring" used throughout the specification.

The present invention is drawn to a multilayered air-fuel ratio sensor having: (i) a plurality of multilayered substrate layers, made up of at least two *solid electrolytic layers* and at least one *insulating layer*, and (ii) a plurality of *boundary layers*. The boundary layers are made of a heterogeneous material which is different from that of the substrate layers. A non-limiting example of the present invention is shown in Figure 7, of the present specification.

The plurality of boundary layers are in turn located at the respective boundaries or surfaces of the multilayered substrate layers. The plurality of boundary layers are also classified into 1<sup>st</sup> and 2<sup>nd</sup> heterogeneous boundary layers,

wherein the 1<sup>st</sup> heterogeneous boundary layer is interposed between two adjacent solid electrolytic substrate layers and the 2<sup>nd</sup> heterogeneous boundary layer is interposed between the solid electrolytic substrate layer and the insulating substrate layer, the latter two of which are located adjacent to each other.

According to the present invention, having the heterogeneous boundary layers interposed between the respective boundaries of a multilayered substrate layers helps to absorb stress, such as thermal shocks, and thereby reduces the formation and growth of cracks within the sensor. This subsequently results in improved strength of the sensor body and reduces damage thereto.

**Rejections under 35 U.S.C. § 112, 2<sup>nd</sup> Paragraph**

Claims 1-5 stand rejected under 35 U.S.C. § 112, 2<sup>nd</sup> paragraph as allegedly being indefinite. The Examiner asserts that the term “heterogeneous” is vague and does not clearly indicate whether the boundary has more than one component or if the boundary has a different composition than the other layers. Applicants’ respectfully traverse this rejection in view of the above claim amendments.

The claims have been amended to define that a plurality of boundary layers are located at respective boundaries of the multilayered substrate layers, and each boundary layer is made of a heterogeneous material different from that of the substrate layers. Applicants assert that the claims are now definite and withdrawal of this rejection is respectfully requested.

**Rejections Under 35 U.S.C. § 102(b)**

Applicants respectfully request that the Examiner refers to the attached *Comparison Table* which points out the distinctions between the present invention and the inventions of the cited prior art in conjunction with the discussion below.

***Mase et al. - U.S. Patent No. 4,558,126***

Claims 1-2 and 4-5 stand rejected under 35 U.S.C. § 102(b) as allegedly being anticipated by Mase et al. (U.S. Patent No. 4,558,126), hereinafter Mase '126. The Examiner asserts that the present invention is anticipated because Mase '126 discloses a plurality of solid electrolytic layers (1, 3 and 4), boundary layers (12 and 31) interposed between the solid electrolytic layers and insulating layer (8).

Applicants respectfully traverse this assertion for the reasons below.

A close reading of Mase '126 indicates that the patent discloses an electrochemical sensor having: (i) three solid electrolytic layers (1, 3 and 4); (ii) two ceramic layers (8 and 9); and (iii) an a ceramic electrical insulating layer (12). The arrangement of the respective layers as shown in Figure 2, is such that ceramic layer 8 is laid on ceramic layer 9; the insulating layer 12 is placed on top of ceramic layer 9; solid electrolytic layer 4 is placed on top of the insulating layer 12; and solid electrolytic layers 3 and 1 are respectively placed on layer 4.

In Figure 3, the configuration is essentially the same as that for Figure 2, except that another insulating layer 29, is placed on solid electrolytic layer 1, and is subsequently covered by an additional ceramic layer 30.

Figure 4, shows a three layer ceramic component (9, 8 and 32) placed on top of a three layer solid electrolytic component (1, 3 and 4). The insulating layer is not part of this sensor configuration.

Contrary to the Examiner's assertion that layers 12 and 31 are *boundary layers*, Mase '126 specifically discloses that these layers are high-electric resistance layers which function to insulate the solid electrolytic layers 1, 3 and 4, from the ceramic layers 8 and 9, so that the current leaked from the heater 10 (held between layers 8 and 9), is restricted only to the ceramic layers 8 and 9. Therefore, the reference layers 12 and 31 are not contemplated as applicants' heterogeneous boundary layers, as suggested by the Examiner.

The present invention is drawn to a sensor having the above described components arranged in a specific manner, which is not taught by Mase '126. Specifically, a first heterogeneous boundary layer is interposed between two adjacent solid electrolytic layers, and a second heterogeneous boundary layer is interposed between a solid electrolytic layer and an insulating layer, which are adjacent to each other. Mase '126 does not teach the presence of a heterogeneous boundary layer (or any layer) between any of the solid electrolytic layers 1, 3 or 4.

The standard of anticipation under 35 U.S.C. § 102 requires that all material elements of the claimed invention be taught by the cited reference. *In re Marshall*, 198 USPQ 344, 346 (CCPA 1978). The disclosure of Mase '126 does not satisfy this standard because there is no teaching of (i) a heterogeneous boundary layer and (ii) the placement thereof between two adjacent solid electrolytic layers and between a solid electrolytic layer and an adjacent insulating layer. Withdrawal of this rejection is respectfully requested.

**Mase et al. - U.S. Patent No. 4,755,274**

Claims 1-2 and 4-5 stand rejected under 35 U.S.C. § 102(b) as allegedly being anticipated by Mase et al. (U.S. Patent No. 4,755,274), hereinafter Mase '274. The Examiner asserts that the present invention is anticipated because Mase '274 discloses a plurality of substrate layers and a boundary layers (10) interposed between two substrate layers (8 and 22). Applicants respectfully traverse this assertion for the reasons below.

A close reading of Mase '274 indicates that the patent discloses an electrochemical sensor having: (i) a *sensing cell (2)* containing a solid electrolyte material layer (12), and (ii) a *pumping cell (4)*, also containing a solid electrolyte material layer (22). The sensing cell and pumping cell are separated by a ceramic layer (10) applied on top of the solid electrolyte material layer (22), and a spacer layer (8), also made of a solid electrolyte material layer, applied on top of the ceramic layer (10). See descriptions of Figures 1, 3, 5, 7 and 9.

The ceramic layer 10 functions to block the current leaked from the pumping cell to the sensing cell, when a pumping voltage is applied between the outer and inner pumping electrodes (14 and 18). This layer, therefore, serves as an electrical insulating layer. This function is contrary to the Examiner's assertion that layer 10 is a boundary layer.

Even if layer 10 were considered to be a *boundary layer*, Mase '274 discloses the use of only one such layer, and fails to teach the use of a plurality of heterogeneous boundary layers. Further, while layer 10 is placed between two solid electrolytic layers, there is no teaching of placing a second heterogeneous boundary layer between a solid electrolytic layer and an adjacent insulating layer. For the

above reasons, Mase '274, therefore, does not anticipate the present invention. Withdrawal of this rejection is respectfully requested.

**Rejection Under 35 U.S.C. § 103**

Claim 3 stands rejected under 35 U.S.C. § 103(a) as allegedly being obvious over Mase '126 or Mase '274, alone, or either of Mase '126 or Mase '274 in combination with Suzuki, et al. (U.S. Patent No. 4,177,112). These rejections are respectfully traversed for the reasons stated below.

***Mase '126 or Mase '274 - Alone***

Under the standard of obviousness established for 35 U.S.C. § 103, where a single reference is cited by the Examiner as a basis for obviousness, that reference must provide sufficient guidance to lead one of ordinary skill in the art to the invention claimed by applicants. Where a single reference lacks a teaching or suggestion of material components of the claimed invention, the primary reference must provide sufficient motivation to lead one of ordinary skill in the art to the teaching of a secondary reference which, when combined with the teaching of the primary reference, renders the claimed invention obvious.

Claim 3 of the present invention is dependent on independent claim 1 and therefore, has all of the limitations of the independent claim. Consequently, the cited references must first teach or suggest the elements of claim 1, in addition to the dependent limitation of claim 3.

The Examiner asserts that either of the Mase patents cited to establish anticipation under 35 U.S.C. § 102(b) above, are equally suitable for establishing obviousness under 35 U.S.C. § 103. Applicants respectfully disagree, because as discussed above in the arguments with respect to anticipation, both of the cited

Mase patents lack a teaching or suggestion of various elements claimed by applicants in independent claim 1. Specifically, Mase '126 lacks a teaching or suggestion of a stacked layering configuration having: (i) a heterogeneous boundary layer and (ii) the placement thereof between two adjacent solid electrolytic layers and between a solid electrolytic layer and an adjacent insulating layer. Mase '276 lacks a teaching or suggestion of: (i) the use of a plurality of heterogeneous boundary layers and (ii) placing a second heterogeneous boundary layer between a solid electrolytic layer and an adjacent insulating layer.

One of ordinary skill in the art relying on the teachings of either of the cited Mase patents alone, therefore, has no guidance or motivation to modify the teaching in a manner that would render the present invention obvious. Further, it is not readily apparent from either of the cited Mase patents, why such a modification of the stacking array pattern and compositional make-up, would even be desirable, or how (or why) one of ordinary skill in the art would arbitrarily choose the specific modifications that would render the claimed invention obvious. Lastly, the Examiner has not provide any rationale to support the assertion of obvious over either Mase patent, in the absence of any suggestion by Mase to make the modification. A *prima facie* case of obviousness has not been established and withdrawal of the rejection over both Mase patents is respectfully requested.

***Mase '126 or Mase '274 in view of Suzuki***

The Examiner asserts that neither of the Mase patents disclose applicants' claimed embodiment of the boundary layer having a sintering particle diameter larger than that of neighboring layers. Therefore, Suzuki is cited as an attempt to cure the defect left by each of the Mase patents. Specifically, Suzuki is cited for its teaching

of forming a more porous layer by starting with larger particles than a neighboring layer. Suzuki, column 2, lines 38-49. The Examiner concludes that it would have been obvious to one of ordinary skill in the art to use the teaching of Suzuki to modify the sensor of either of the Mase patents, in a manner that would render the present invention obvious. Applicants respectfully traverse this assertion.

A close reading of Suzuki indicates that the patent is drawn to a oxygen sensor having a substantially distinct structure and compositional make-up than either of the cited Mase patents. Compare Suzuki Figure 1, with Mase '126, Figure 2 and Mase '274, Figure 1. Specifically, Suzuki discloses a sensor wherein the sensing component (1) is a single layer solid electrolytic composition (*i.e.*,  $\text{ZrO}_2$ ), having a platinum electrode (2 and 3) layered on inner and outer surface of the sensing component (1). *Id.*, Figure 1 and column 2, lines 16-53. The outer surface of the platinum electrode (2) is coated with a first coating (4) of a refractory metal oxide compound (*i.e.*,  $\text{Al}_2\text{O}_3$ ), having a grain size of about 10  $\mu\text{m}$ . A second coating (4') of an  $\text{Al}_2\text{O}_3$  component having a grain size of about 40  $\mu\text{m}$ , is applied to the surface of the first coating (4). The pore size of the second coating (4') is larger than that of the first coating (4).

The above configuration is, however, not suggestive of that which is disclosed by either of the Mase patents. There is no teaching or suggestion of a plurality of solid electrolytic layers, interposed with a plurality of ceramic insulating layers or boundary layers of any kind. Further, Mase discloses a sensor having a rectangular multilayered structure. Suzuki discloses the sensing component encased in a cylindrical housing, having fewer layers than what is taught by either of the Mase patents.



Applicants assert that the Suzuki disclosure is not combinable with either of the Mase patents (hereinafter, “Mase”), as there is nothing in the teaching of Mase that would have lead one of ordinary skill in the art to incorporate the components of Suzuki into the Mase’s sensor. Additionally, Mase does not provide guidance to one of skill in the art as to which elements of Suzuki should be incorporated into the Mase sensor. Lastly, there is no indication from the references why such a modification would even be desirable.

In order for references to be properly combined, it must be apparent from the references that the teachings are combinable. *In re Avery*, 186 U.S.P.Q. 161, 165 (CCPA 1975). Applicants assert that in view of the above, Suzuki is not combinable with Mase. Contrary to the Examiner assertion that the references are combinable, the incentive to combine the references is not readily apparent from their disclosures. Further, the Examiner conclusion of obviousness is not support by an explanation of why the combination is proper. Such an explanation is required where incentive to combine is not apparent from the references. *Ex parte Skinner*, 2 U.S.P.Q.2d 1788, 1790 (BPAI 1990).

Applicants also assert that the Examiner has combined independent elements of the of the prior art to produce the present invention. Obviousness, however, cannot be established in this manner. *In re Geiger*, 2 USPQ.2d 1276, 1278 (CAFC 1987). The combined teachings must provide motivation that would lead one of ordinary skill in the art to combine the relevant teachings of the prior art, so as to render the present invention obvious. *Ashland Oil Inc. v. Delta Resins and Refractories, Inc.*, 227 USPQ 657, 675 (CAFC 1985).

Even assuming for the sake of argument that the references are combinable, (which applicants assert is not the case), Suzuki does not satisfy the deficiencies of

Mase as discussed in the above arguments with respect to anticipation.

Specifically, Suzuki does not teach or suggest heterogeneous boundary layers or their placement between two adjacent solid electrolytic layers and between a solid electrolytic layer and an adjacent insulating layer, missing from both Mase '126; and Mase '276. As such, the teachings are not combinable, as asserted by the Examiner.

Therefore, one of ordinary skill in the art having the teachings of Mase, would not have been motivated to consider combining elements of such structurally divergent configurations of gas sensing devices, absent some motivation to make the combination and guidance showing how to make the combination. No such motivation or guidance has been identified by the Examiner. A *prima facie* case of obviousness, therefore, has not been established and withdrawal of these rejections is respectfully requested.

### CONCLUSION

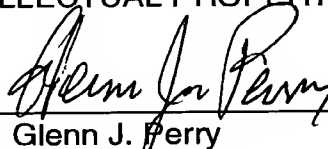
Having fully responded to all outstanding rejection, applicants submit that in view of the above amendments and remarks, claims 1-4 are allowable over the cited prior art. Favorable notification thereof and issuance of an Notice of Allowance are earnestly solicited.

The Examiner is invited to contact the under signed to resolve any issues relevant to the patentability of the claims that remain, in order to advance the prosecution of this application toward allowance.

Respectfully submitted,

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